THE ROTATIONAL SPECTRUM OF BiO IN ITS $X_1{}^2\Pi_{1/2}$ AND $X_2{}^2\Pi_{3/2}$ ELECTRONIC STATES

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BiO has a $^2\Pi_r$ electronic ground state with a fine structure interval of ≈ 7087 cm^{-1} between the X_1 and X_2 states. A recent, far reaching study of the BiO radical by Shestakov, *et al.*,[a] has provided spectroscopic constants for a total of nine of its electronic states. The rotational constants calculated for the $X^2\Pi$ state have been used as the basis for a further investigation by microwave spectroscopy at Nobeyama Radio Observatory. BiO was produced in a flow system by heating Bi to 1120 K in a Knudsen cell and reacting the resulting vapor with an approximately 1:1 mixture of O_2 and argon in the presence of a dc discharge. A useful side-effect of this method of production is the population of highly excited vibrational states of BiO. This is presumably due to collisional energy transfer from the metastable $a^1\Delta_g$ electronic state of O_2. As a result, rotational transitions within vibrationally excited levels up to $v < 9$ in the $X_1\,{}^2\Pi_{1/2}$ electronic state and $v < 5$ in the $X_2\,{}^2\Pi_{3/2}$ state have been observed. A sample microwave spectrum of the BiO radical is given in Figure 1, which illustrates the hyperfine pattern that is associated with the presence of the $I < 9/2$ ^{209}Bi nucleus.

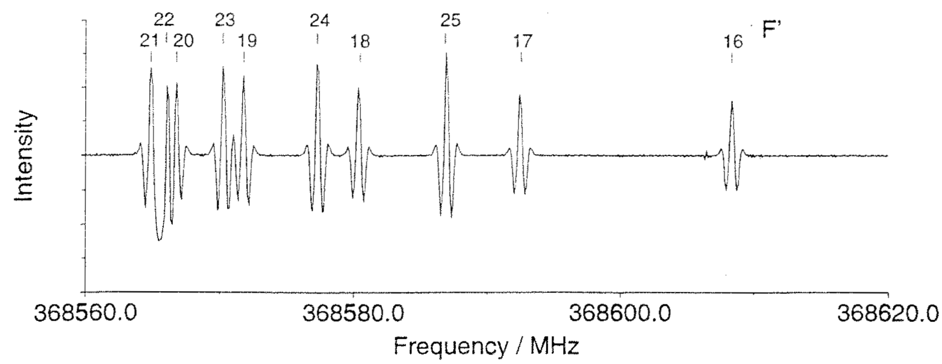

Figure 1: The BiO $X_1{}^2\Pi_{1/2}$ $(v = 0)$ $\Delta F = +1$, $J = 41/2 - 39/2$ transitions.

Thus far, a total of 575 lines have been assigned and fitted with an RMS of 27 kHz, using an effective Hamiltonian similar to that of Brown *et al.*[b] There is excellent agreement between the microwave parameters and those obtained in the optical study. More recently, we have included over 2300 previously assigned transitions of the $X_2 \rightarrow X_1$ 0–0 emission band[c] with an RMS of 0.0009 cm^{-1}. In addition, the hyperfine parameters for both the X_1 and X_2 electronic states have been determined. These will be compared to the corresponding parameters of related compounds and to those of the bismuth atom.

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[a] O. Shestakov, R. Breidohr, H. Demes, K. D. Setzer and E. H. Fink *J. Mol. Spectrosc.* **190**, 28-77 (1998)
[b] J. M. Brown, E. A. Colbourn, J. K. G. Watson and F. D. Wayne, *J. Mol. Spectrosc.* **74**, 294-318 (1979)
[c] E. H. Fink, private communication